THE CONSOLIDATED COMPARTMENT FIRE MODEL (CCFM) COMPUTER CODE APPLICATION CCFM. VENTS - PART IV: USER REFERENCE GUIDE

Glenn P. Forney
Leonard Y. Cooper
William F. Moss

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards
and Technology
Center for Fire Research
Gaithersburg, MD 20899

NIST

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ABSTRACT

A project was carried out at The National Institute of Standards and Technology (NIST) to study the feasibility of developing a new-generation, multi-room, compartment fire model computer code, called the Consolidated Compartment Fire Model (CCFM) computer code. The idea was that such a code would consolidate past progress in zone-type compartment fire modeling, and allow readily for integration of future advances with the greatest possible flexibility. Desired features of the CCFM would include: comprehensive documentation, user-friendliness, significant modularity, numerical robustness, and versatility in the sense that the code would provide a capability of analyzing a particular compartment fire problem by using any one of a range of physical-phenomena-modeling sophistication, from the most basic to the most comprehensive. The project led to the development of a prototype multi-room CCFM product called CCFM.VENTS. CCFM.VENTS involves a model formulation and code structure that allows for the required future CCFM growth flexibility. It has a relatively sophisticated and very general room-to-room forced and unforced vent flow capability. Finally, the CCM.VENTS code uses the simplest possible, point-source-plume, smoke-filling fire physics in the rooms-of-fire-origin and a very simple heat transfer calculation there and in other spaces.

This is Part IV of a four-part report which documents CCFM.VENTS. The main objective of this Part IV document is to document the use of CCFM.VENTS. Its capabilities and limitations are described. A simple two room tutorial is presented to get the user quickly acquainted with the input requirements of CCFM.VENTS. Each CCFM.VENTS command is described. Finally, a program for plotting CCFM.VENTS data is presented. This program runs on an IBM-PC or compatibles with a VGA graphics monitor.

The other three parts of this report are: Part I: Physical Basis; Part II Software Reference Guide; Part III: Catalog of Algorithms and Subroutines.

Keywords: building fires; compartment fires; computer models; fire models; mathematical models; vents; zone models

1. Introduction

1.1 Background

A project was carried out at The National Institute of Standards and Technology (NIST) to study the feasibility of developing a new-generation, multi-room, compartment fire model computer code, called the Consolidated Compartment Fire Model (CCFM) computer code. The idea was that such a code would consolidate past progress in zone-type compartment fire modeling, and allow readily for integration of future advances with the greatest possible flexibility. Desired features of the CCFM would include: comprehensive documentation, user-friendliness, significant modularity, numerical robustness, and versatility in the sense that the code would provide a capability of analyzing a particular compartment fire problem by using any one of a range of physical-phenomena-modeling sophistication, from the most basic to the most comprehensive. The project led to the development of a prototype multi-room CCFM product called CCFM.VENTS. CCFM.VENTS involves a model formulation and code structure that allows for the required future CCFM growth flexibility. It has a relatively sophisticated and very general room-to-room forced and unforced vent flow capability. Finally, the CCM.VENTS code uses the simplest possible, point-source-plume, smoke-filling fire physics in the rooms-of-fire-origin and a very simple heat transfer calculation there and in other spaces.

CCFM.VENTS is designed to be easily used and can be installed on readily available micro-computer hardware.

This user's reference guide is the last of a four-part report which documents all aspects of CCFM.VENTS.

In Part I [2], introductory remarks discuss the generic features of CCFM, the CCFM development process, and the specific features of CCFM.VENTS. The main objective of Part I is to present a comprehensive description and technical basis of the governing equations used in CCFM.VENTS.

Part II [3] is a software reference guide. It presents the generic and CCFM.VENTS-specific features of the framework of CCFM software. This includes features of both program and data structures; numerical considerations used to treat the solution to the CCFM equation set; and a presentation of methods of using the CCFM structure to generate stages of the computer model

beyond CCFM.VENTS.

Part III [4] is a catalog of all the physical algorithms and associated modular computer subroutines used in CCFM.VENTS. The purpose of the catalog is to allow the interested user to learn, with relative ease and to any required level of detail, how the software carries out any particular aspect of the overall CCFM simulation. The catalog algorithm/subroutine entries are also available for use by people who may be interested in developing for their own particular needs a compartment fire model computer program other than the CCFM.

This document, Part IV, is the CCFM.VENTS user's reference guide. The main objective is to provide a guide that will allow the user of the program to easily and quickly simulate compartment fire scenarios of particular interest.

1.2 An Overview of CCFM.VENTS Capabilities and Inputs

CCFM.VENTS is a multi-room compartment fire model. It involves a relatively sophisticated and very general room-to-room forced and unforced vent flow capability. The program uses the simplest possible, point-source-plume, smoke-filling fire physics in the rooms-of-fire-origin and a very simple heat transfer calculation there and in other spaces. The model can also be used to simulate wind conditions and stack effect.

To carry out a particular fire simulation with CCFM.VENTS the user must supply information on the characteristics of the rooms, the natural vents, the forced vents, the fires, and the outside environment. Also required are the initial conditions which describe the state of the two-layer environment in each room of the simulated facility. The model requires inputs which describe the plan area, and ceiling heights of each room of the modeled facility. The area and top and bottom elevations of adjacent-room rectangular vents (i.e., doors, windows, and cracks) are also required as input. CCFM.VENTS uses a specified fire. A **specified fire** consists of pairs of values for time and energy release which describe the fire's growth throughout the course of the simulation. Depending on the type of simulation required, other input data are also required, e.g., to simulate the action of forced ventilation systems, wind and stack effects, and concentrations of products of combustion throughout the facility.

The physical units used in CCFM.VENTS are given in Table 1.1.1.

Table 1.1.1   CCFM.VENTS Physical Units

quantity	Unit
length	[m]
area	[m^2]
volume	[m^3]
mass	[kg]
density	[kg/m^3]
product concentration	[unit of product/kg of total mass]
pressure	[p] = [N/m^2] = [kg/(m s)^2] note: 101325 [Pa] ≈ 1 atmosphere
temperature	[K]
power	[w]

To orient the CCFM.VENTS user, an overview of inputs to the program will be discussed in Section 2 and the functions of some of the main CCFM.VENTS input commands will be introduced. The detailed mechanics of implementing all CCFM.VENTS input are described in Section 3: Getting Started and in Section 4: Setting Up a Case. Section 3 provides a tutorial on how to get started quickly in implementing CCFM.VENTS by bringing the user through the input procedure for a simple two-room fire scenario. Section 4 explains several different methods for entering data to CCFM.VENTS, including: using commands, using screen input, and using a system text editor to modify an input file for a pre-existing case. Section 5 lists and identifies the components of all CCFM.VENTS commands. Finally, Section 6 presents how to use a plotting program provided with the IBM-PC version of CCFM.VENTS.

2.   Inputs to Specify the Fire Scenario

2.1   Inside Room Geometry and the Outside Environment

Independent sets of numbers are used to designate the inside rooms, the natural vents, and the forced vents (i.e., the fan/vent systems) of a facility of interest.

When dealing with wind environments and for other applications, it will be useful to divide con-

ceptually the outside environment into a number of different spaces. These outside spaces, referred to as outside "rooms," within the context of CCFM.VENTS would also be given designations from an independent numbering system. When identifying one of these outside spaces, e.g., to specify that it is one of the two spaces joined by a vent, its assigned integer in the specification is distinguished from that of the inside room by use of the negative of its designated integer value. In what is likely the most typical of simulated fire scenario, when the outside environment is taken to be quiescent and uniform, only one outside space is required. This space would be designated as outside-environment space 1, or outside room 1.

The specified geometric properties of each inside room are the elevation of the floor relative to a datum elevation, the elevation of the ceiling above the floor, and floor area. These are entered using the **ROOM** command.

A summary of CCFM.VENTS input bounds are given in Table 2.1.1.

Table 2.1.1   CCFM.VENTS Parameter Bounds

bound	description
9	maximum number of inside rooms
4	maximum number of outside rooms
20	maximum number of vents (unforced+forced vents)
20	maximum number of fires
5	maximum number of products of combustion

Analogous to the floor-elevation specification for each inside room, is a specified reference elevation above the datum elevation for each outside room.

The specified properties of each outside room are (1) the reference elevation, relative to the datum elevation; (2) the reference pressure, relative to the datum pressure, at the latter elevation; (3) the density; and the concentration in the outside room of all simulated products of combustion. All of these outside room properties are entered using the **AMB** command.

2.2   Natural and Forced Vent Characteristics

A pair of rooms can exchange mass, enthalpy, and products of combustion through natural, unforced vents and forced vents. Natural vents are rectangular openings in vertical wall segments common to two adjacent rooms. Forced vents are made up of fan/duct ventilation systems. Each one of these systems has a single endpoint duct opening in each room of the pair being connected by the system.

The specified properties of each natural vent are (1) the numerical designation of the vent; (2) the numerical designation of the two inside rooms (or the inside room and outside room) connected by the vent, one of these being identified arbitrarily as the "from" room and the other as the "to" room; (3) the area of the vent; and (4) the elevations, above the floor of the "from" room, of the bottom and top of the vent. All of these are entered using the **VENT** command.

The specified properties of each forced vent are: the numerical designation of the vent, the numerical designation of the "from" room and the "to" room under normal fan-operating conditions; the elevations above the floors of their respective rooms of the midpoints of the fan/duct system endpoints; and the heights of the rectangular duct end-point vents in the "from" and in the "to" rooms. If the volume flow rate through the vent is known, then the value of this flow rate must be specified. If the volume flow rate is to be calculated from the vent/duct forced ventilation system, the also specified are the flow resistances of the duct during forward and backward flow conditions; and a set of pairs of values of volume flow-rate and cross-fan pressure which identify points on the fan curve. All of the forced-vent specifications are entered using the **FVENT** command.

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2.3   The Fire

CCFM.VENTS is limited to specified fires. Thus, the effect of the fire environment on fire growth can only be taken account of by explicit user specification of the fire's energy- and product-release rates. For the results of a CCFM.VENTS simulation to be credible, it is the responsibility of the user to insure that the CCFM.VENTS-predicted environment in a room of fire origin (e.g., the predicted oxygen concentrations and temperatures of the layers) is consistent with the user-specified fire growth.

The specified properties of a fire are: the numerical designation of the fire; the number of the room that contains the fire; the elevation of the fire above the floor; and a set of pairs of values of energy release-rate and time which identify points on the specified curve of fire-energy-release-rate vs time. In the simulation, the fire-energy-release-rate at an arbitrary time is obtained by interpolating between or extrapolating beyond the specified data points. The above fire characteristics are entered using the **FIRE** command.

A set of integers is used to number and designate those products of combustion whose concentrations are to be simulated. At an arbitrary instant of time it is assumed that a fire's release rate of product-of-combustion k, $\dot{P}_{k,SOURCE}$, can be reasonably modeled as being proportional to the energy-release-rate of the fire, i.e.,

$$\dot{P}_{k,SOURCE} = factor_k \dot{Q}$$

Thus, for product k, the specified property of the product-generation-rate is the constant, $factor_k$. The default product of combustion for k = 1 is oxygen and a default value for $factor_1$ is specified as $-0.076(10^{-6})$ [(kg of O_2)/W]. For other products, it is reasonable to choose the $factor_k$'s based on experimental free burn data of the combustible being simulated. With such choices, the product generation rates would be well simulated at least until the combustion zone was predicted to be submerged in a significantly vitiated local environment. The proportionality constants, $factor_k$, are entered using the **FACTOR** command.

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2.4   Determining the Fire Environment and Specifying the Initial Conditions

CCFM.VENTS determines the fire environment in each inside room from the values of the solved variables: pressure at the floor above a datum pressure; elevation of the interface which separates the layers; mass in the upper and lower layers; and the amount in the upper and lower layers of each simulated product k. From an equation of state and from the definition of density and concentration by mass, CCFM.VENTS calculates from the solution variables the values of the temperatures, densities, and concentrations of gasses in the layers. All of these latter calculated variables are derived variables.

The environment in each room of the facility must be initialized. This is done by defining the initial values of the solution variables with the use of the **INIT** and **INITP** commands. The burden of initializing all rooms of a facility is simplified significantly through use of the **AUTO** command. **AUTO** sets up the initialization for a simulation under the assumptions that: the upper layer in each room is of zero thickness, i.e., the interface is at the ceiling; throughout all inside rooms of the facility and all outside rooms of the environment the density and concentration of each product of combustion are at uniform user-specified values; the pressure at the floor of each room of the facility is set so that, in the absence of a fire or of operating forced ventilation systems, zero flow conditions would persist through all natural vents.

Although the use of the **AUTO** command feature may not initialize a particular scenario as desired, it is typically useful to use **AUTO** and to then make modifications as required to the resulting initialized variables.

2.5   Specifying a Simulation Which Accounts for Wind Loading and/or Stack Effect

CCFM.VENTS is capable of simulating the effects of wind loading and/or stack effect. The reader is referred to Section 4 of Part I [2] for a more detailed discussion of the basis of this capability.

2.5.1   Simulating Wind Loading

The CCFM.VENTS capability of designating multiple outside spaces can be used to simulate the

pressure distributions at different vent locations on the exterior of a facility in a wind environment. One possible method of using CCFM.VENTS to simulate such wind conditions is outlined briefly below.

Designate outside room 1 as a quiescent environment and specify its density, ρ_{AMB}, reference pressure, p_{REF}, and reference elevation, y_{REF}.

Now assume that the quiescent environment has a uniform far-field wind velocity with wind speed, v_{WIND}.

Consider a vent of a facility of interest which is exposed to the outside wind environment. Assume that an analysis of wind flow around the facility allows one to determine the local pressure coefficient, $C_{PRESSURE}$ at the location of the exposed-side of the vent of interest. Thus, if $\delta_{PQUIESCENT}$ and δ_{PWIND} are the relative outside pressures local to the vent in the quiescent and wind environments, respectively, then, by definition of $C_{PRESSURE}$

$$\delta_{PWIND} = \delta_{PQUIESCENT} + C_{PRESSURE}\ (\rho_{AMB}v_{WIND}^2/2)$$

In view of the above, a new outside space is introduced, where the new space is defined as having the same properties of the original quiescent-environment space, but with a new reference pressure specified to be

$$\delta_{PREFNEW} = \delta_{PREF} + C_{PRESSURE}\ (\rho_{AMB}v_{WIND}^2/2)$$

The "room" on the exposed side of the vent of interest is now designated as this new outside space.

Now the above procedure is repeated for each exposed vent of the facility. At the end of the

process there will be defined one outside space for each unique value of $C_{PRESSURE}$.

With the modified input data, the CCFM.VENTS simulation would now include the desired effect of wind loading.

2.5.2 Simulating Stack Effect

Flows through natural vents located on the exterior walls of the facility (e.g., cracks, open windows, or doors) can be driven by cross-vent pressure differences which are set up as a result of a density difference between the interior of a facility and the outside environment. The flow exchange phenomenon is called stack effect.

The combined phenomena of stack-effect-driven flows and fire-driven flows can be simulated with CCFM.VENTS. One possible way to do this is outlined briefly:

Initialize the simulation using **AUTO**, setting the uniform inside and outside density at the desired inside value. Now modify the outside environment by specifying the desired outside density using **AMB**.

With the modified input data, the CCFM.VENTS simulation will include the desired phenomenon of stack effect. Further modification according to Section 2.5.1 leads to a capability of simulating the combined effect of fire, wind, and stack effect.

3. Getting Started

General information about a command may be obtained by typing **HELP** followed by the command. The usage, purpose and pertinent background information concerning the command will then be displayed. Information about the values of CCFM.VENT variables may be obtained by entering commands without arguments. This feature of the input module may be used to verify the values of entered data.

Note : It is clear that CCFM.VENTS displays many more digits than are <u>physically</u> meaningful. The extra digits displayed are needed for investigating numerical problems that might occur in a physical calculation. For example, numerical cancellation will typically show up in the last few digits in a calculation.

3.1 The Default Case

CCFM.VENTS Case 3.1.1 contains a listing of the commands that are used to specify the default fire scenario for CCFM. This is the case that will be run if you type **BEGIN** immediately after you startup CCFM.VENTS. It is a one room case with a fire with a constant energy release rate of 250,000 watts. The area of the floor is 20m^2, the ceiling height is 3m and it has one vent about the size of a door.

CCFM Case 3.1.1   CCFM Commands for the Default Fire Scenario

---

```
; ------------------------------------
; PROPERTIES INDEPENDENT OF TIME
; ------------------------------------

TIME , , ,    .1000E+01    .1000E+01 N
NUM    -1  -1  -1  -1  -1
CONS   .3500E+00    .8000E+00    .6000E+00    .10000E+04  .1013250E+06
CONV ABS    .1000E-05    .1000E-05    .1000E-05    .1000E-02    .1000E-02
CONV REL    .1000E-05    .1000E-05    .1000E-05    .1000E-02    .1000E-02
PARMS  2 N N
PATH
FILES,OUT1,OUTFULL,PLOTF
REPOF' Y N N Y Y N
OPTI'   N,,Y,, N
TITLE DUMP    DUMP TITLE
TITLE OUTPUT OUTPUT TITLE
TITLE PLOT    PLOT TITLE
```

```
; FIRE PROPERTIES

FIRE   1  1   .000000E+00    .250000E+06

; ROOM DIMENSIONS

ROOM  1   .0000E+00   .3000E+01   .2000E+02

AMB  1   .0000E+00   .0000E+00   .1200E+01
AMB  1 ,,,,

; VENT DIMENSIONS

VENT  1  1 -1   .20000E+01   .00000E+00   .20000E+01

; NO PRODUCTS DEFINED


;    ------------------------------------
;         PROPERTIES THAT DEPEND ON TIME
;    ------------------------------------

TIME 0. 20.
INIT  1   .00000000E+00   .30000000E+01   .12000000E+01   .12000000E+01
```

To start up CCFM.VENTS on an MS-DOS compatible micro-computer, move to the directory containing CCFM.VENTS and type **CCFM**. To run the default case type **BEGIN** as soon as the program starts up. The output generated on the screen by CCFM.VENTS when running the default case is as follows:

```
CCFM>BEGIN

THE FILE,OUTFULL,HAS BEEN OPENED
THE FILE,PLOTF,HAS BEEN OPENED
THE FILE,OUT1,HAS BEEN OPENED
*** GENERAL *** TIME=   .000000E+00
             PRESSURE       LAYER HEIGHT       L. TEMP         U. TEMP
   ROOM= 1   .000000000E+00   .300000000E+01   .295531250E+03   .295531250E+03
DERIVS=      .333333333E+03  -.115148778E+00   .259438382E+01  -.259438382E+01
*** GENERAL *** TIME=   .100000E+01
             PRESSURE       LAYER HEIGHT       L. TEMP         U. TEMP
   ROOM= 1   .672121186E-02   .288821273E+01   .295531256E+03   .315422191E+03
DERIVS=     -.848107350E-06  -.108519105E+00   .243527181E+01  -.260445866E+01
*** GENERAL *** TIME=   .200000E+01
             PRESSURE       LAYER HEIGHT       L. TEMP         U. TEMP
   ROOM= 1   .672121183E-02   .278278473E+01   .295531256E+03   .316044946E+03
DERIVS=     -.237595911E-07  -.102421308E+00   .228892466E+01  -.245811150E+01
*** GENERAL *** TIME=   .300000E+01
             PRESSURE       LAYER HEIGHT       L. TEMP         U. TEMP
```

```
    ROOM= 1   .672121163E-02   .268321076E+01   .295531256E+03   .316671767E+03
DERIVS=       .388492985E-05  -.968017393E-01   .215405501E+01  -.232324185E+01

                                                      *
                                                      *
                                                      *


*** GENERAL *** TIME=   .180000E+02
              PRESSURE      LAYER HEIGHT      L. TEMP         U. TEMP
    ROOM= 1   .519595094E-03   .167839745E+01   .295531261E+03   .326522142E+03
DERIVS=      -.162089072E-02  -.421727635E-01   .856487976E+00  -.101214675E+01
*** GENERAL *** TIME=   .190000E+02
              PRESSURE      LAYER HEIGHT      L. TEMP         U. TEMP
    ROOM= 1  -.427530503E-04   .163766854E+01   .295531262E+03   .327200319E+03
DERIVS=       .483494437E+00  -.392965723E-01   .790682431E+00  -.942983736E+00
*** GENERAL *** TIME=   .200000E+02
              PRESSURE      LAYER HEIGHT      L. TEMP         U. TEMP
    ROOM= 1  -.707380739E-03   .159974475E+01   .295531263E+03   .327879204E+03
DERIVS=      -.587761398E-02  -.365674295E-01   .728290750E+00  -.877620277E+00
```

3.2   A Two Room Tutorial

This section provides an example of a simple 2-room fire scenario. The case is illustrated in Figure 3.2.1 and data for it is given in Table 3.2.1
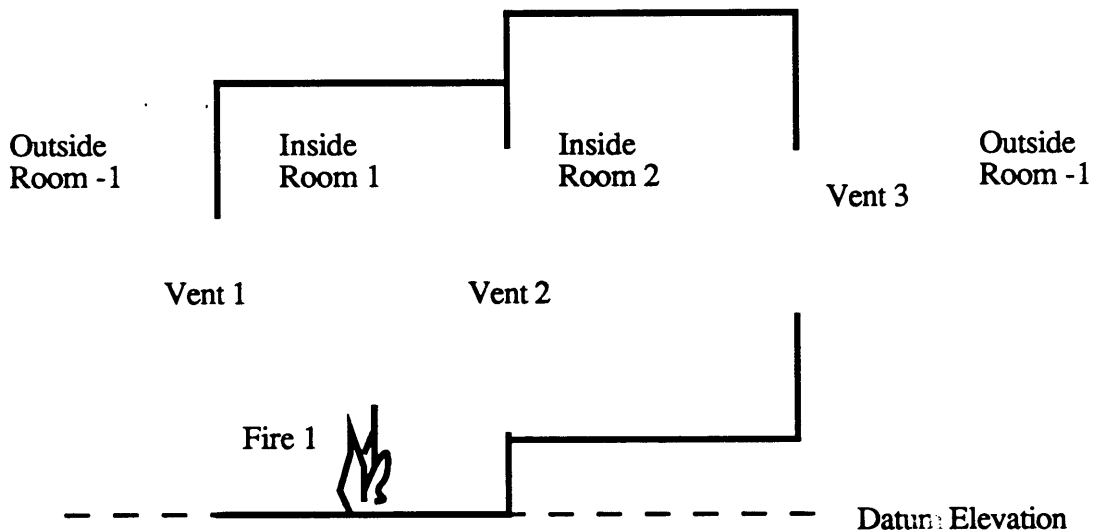

Figure 3.2.1   Sample Two Room Case

The dimensions for this example are typical of those found in residential buildings. This case consists of two rooms. The first room is connected to the second room and the outside via an open

door. The second room is connected to the outside via an open window. The floor of the second room is at a different elevation than the first. The fire is constant with an energy release rate of 300,000 w. This is typical of a small sofa or chair. The floor areas in each room are 25 [m²] and the ceiling heights are 3.0 [m]. The floor height is measured with respect to the datum elevation while the ceiling, layer, vent top and bottom elevations are measured with respect to the floor elevation.

Table 3.2.1	Two Room Input Scenario		

Inside Room	Floor Height*[m]	Floor Area [m²]	Ceiling Height**[m]
1	0.	25.	3.
2	.5	25.	3.

Vent	bottom***[m]	top*** [m]	area [m²]	from room****	to room****
1	0.	2.	2.	1	-1
2	1.	3.	2.	1	2
3	1.	2.	1.	2	-1

Fire	Fire Height** [m]	Fire Size [w]
1	0.	300,000

*	floor heights are measured with respect to the datum elevation
**	ceiling height are measured with respect to the floor elevation
***	vent heights are measured with respect to floor elevation of the "from" room
****	outside room numbers are negative

CCFM commands entered by the user are presented **bold**. Notes and explanatory text are presented in *italics* . Text generated by CCFM.VENTS is presented using UPPER-CASE.

To start CCFM type:

ccfm

followed by the "enter" key. The following menu of CCFM commands will appear. Information about these commands is contained in section 5 of this user's guide. On-line help for each command may be obtained by typing **help com1** *where com1 is one of the following menu commands.*

```
INITIALIZING MENUS
 ITRACE=N IBRIEF=N ITTY=Y LEVEL= 0 IBATCH=N
               CCFM.VENT
CONSTANTS  MODEL     OUTPUT      MISC
------------------------------------------------
CONS       ROOM      PATH        OPTIONS
NUM        FIRE      FILES       BEGIN
CHECK      VENT      TIME        QUIT
CONV       FVENT     REPORT      LOAD
PARMS      INITP     TITLE       RERUN
FACTOR     INIT      VALUES      DUMP
AMB        AUTO                  HELP
```

The output from this case is contained in the file OUTFULL. To change the file names use the FILES command.

To enter the two room scenario described by Figure 3.2 and Table 3.1. use the commands room, vent, fire and time. After starting CCFM.VENTS enter room 1 to specify data for the first room. The default data for room 1 is displayed. Some of these entries will be changed to values needed for the two room case.

CCFM> **room 1**

```
 SCREEN INPUT MODE FOR COMMAND:ROOM
FIELD                     DESCRIPTION                        CONTENTS
    1    INSIDE ROOM NUMBER                           1
    2    FLOOR HEIGHT ABOVE DATUM ELEVATION [M]       .0000E+00
    3    CEILING HEIGHT ABOVE FLOOR [M]               .3000E+01
    4    FLOOR AREA [M**2]                            .2000E+02

SCREEN OPTIONS:
   1 -->  4 ALTER CORRESPONDING FIELD
   (D)ISPLAY SCREEN              (H)ELP
   (O)K - EXIT WITH ENTERED DATA   (C)ANCEL - EXIT WITH ORIGINAL DATA
   (R)EVERT TO ORIGINAL DATA
SCREEN>
```

*Each screen command contains three columns labeled FIELD, DESCRIPTION and CONTENTS. To change a field's contents type the field number followed by the new value. Type **4 25.** **display** to change the floor area to 25m² and refresh the screen.*

Important Note: *Only the first character of the screen commands: display, help, ok, cancel, revert, are required. So you may abbreviate these commands with d, h, o, c and r respectively.*

---

4 25. display

```
SCREEN INPUT MODE FOR COMMAND:ROOM
FIELD                   DESCRIPTION                            CONTENTS
   1   INSIDE ROOM NUMBER                           1
   2   FLOOR HEIGHT ABOVE DATUM ELEVATION [M]       .0000E+00
   3   CEILING HEIGHT ABOVE FLOOR [M]               .3000E+01
   4   FLOOR AREA [M**2]                            25.

SCREEN OPTIONS:
   1 --> 4 ALTER CORRESPONDING FIELD
   (D)ISPLAY SCREEN              (H)ELP
   (O)K - EXIT WITH ENTERED DATA    (C)ANCEL - EXIT WITH ORIGINAL DATA
   (R)EVERT TO ORIGINAL DATA
SCREEN>
```

To exit screen mode type **ok**. *Notice that CCFM.VENTS displays the room data on the screen that was entered.*

? **ok**

```
ROOM= 1 YFLOR=   .0000E+00 YCEIL=   .3000E+01 AROOM=   .2500E+02
                    CCFM.VENT
CONSTANTS  MODEL     OUTPUT     MISC
-------------------------------------------------
CONS       ROOM      PATH       OPTIONS
NUM        FIRE      FILES      BEGIN
CHECK      VENT      TIME       QUIT
CONV       FVENT     REPORT     LOAD
PARMS      INITP     TITLE      RERUN
FACTOR     INIT      VALUES     DUMP
AMB        AUTO                 HELP




CCFM>
```

By default ,CCFM's menu is printed out after each command is entered. A change in this behavior may be desired after familiarity with CCFM.VENTS is achieved . To do this enter the option command.

? **options**

```
SCREEN INPUT MODE FOR COMMAND:OPTIONS
FIELD                    DESCRIPTION                              CONTENTS
   1    TRACE PROGRAM FLOW (Y,N) - NOT USED          N
   2    INHIBIT MENU D ;PLAY AFTER EACH COMMAND       N
   3    OUTPUT RESULTS .O TERMINAL                    Y
   4    MINIMUM LEVEL OF MESSAGE PRINTED (0,1,2)      0
   5    PROGRAM TO BE EXECUTED IN BATCH MODE          N

SCREEN OPTIONS:
   1 -->   5 ALTER CORRESPONDING FIELD
   (D)ISPLAY SCREEN                  (H)ELP
   (O)K - EXIT WITH ENTERED DATA    (C)ANCEL - EXIT WITH ORIGINAL DATA
   (R)EVERT TO ORIGINAL DATA
SCREEN>
```

To turn off the menu display, change field 2 to y by typing 2 y ok

? **2 y ok**

```
   ITRACE=N IBRIEF=Y ITTY=Y LEVEL= 0 IBATCH=N
CCFM>
```

To enter room 2's characteristics type:

? **room 2**

```
SCREEN INPUT MODE FOR COMMAND:ROOM
FIELD                    DESCRIPTION                              CONTENTS
   1    INSIDE ROOM NUMBER                                2
   2    FLOOR HEIGHT ABOVE DATUM ELEVATION [M]
   3    CEILING HEIGHT ABOVE FLOOR [M]
   4    FLOOR AREA [M**2]

SCREEN OPTIONS:
   1 -->   4 ALTER CORRESPONDING FIELD
   (D)ISPLAY SCREEN                  (H)ELP
   (O)K - EXIT WITH ENTERED DATA    (C)ANCEL - EXIT WITH ORIGINAL DATA
   (R)EVERT TO ORIGINAL DATA
SCREEN>
```

Several fields may be changed at once. In this case, field's 2, 3 and 4 will be changed . To exit
screen mode immediately, let the last parameter be an ok (exit with saved data). Again note that
only the first character of ok, 'o' is required.

? **2 .5 3 2.5 4 ⏚. ok**

```
   ROOM= 2 YFLOR=   .5000E+00 YCEIL=   .2500E+01 AROOM=   .2500E+02
CCFM>
```

To see the data for all rooms entered so far type the CCFM.VENTS command room without any
room number.

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? **room**

```
ROOM= 1 YFLOR=  .0000E+00 YCEIL=  .3000E+01 AROOM=  .2500E+02
ROOM= 2 YFLOR=  .5000E+00 YCEIL=  .2500E+01 AROOM=  .2500E+02
CCFM>
```

Now the vent characteristics need to be entered. The format for entering data to the vent command is the same as the room command. In fact, the data entry format is the same for all the screen commands. The default data is what is needed for the two room scenario. To enter data for the second vent type:

vent 2

```
SCREEN INPUT MODE FOR COMMAND:VENT
FIELD                     DESCRIPTION                    CONTENTS
    1   VENT NUMBER                              2
    2   FROM ROOM
    3   TO ROOM
    4   VENT AREA [M**2]
    5   VENT BOTTOM HEIGHT [M]
    6   VENT TOP HEIGHT [M]

SCREEN OPTIONS:
    1 -->  6 ALTER CORRESPONDING FIELD
    (D)ISPLAY SCREEN                 (H)ELP
    (O)K - EXIT WITH ENTERED DATA    (C)ANCEL - EXIT WITH ORIGINAL DATA
    (R)EVERT TO ORIGINAL DATA
SCREEN>
```

? **2 1 3 2 4 2. 5 0. 6 2.   display**

```
SCREEN INPUT MODE FOR COMMAND:VENT
FIELD                     DESCRIPTION                    CONTENTS
    1   VENT NUMBER                              2
    2   FROM ROOM                                1
    3   TO ROOM                                  2
    4   VENT AREA [M**2]                         2.
    5   VENT BOTTOM HEIGHT [M]                   1.
    6   VENT TOP HEIGHT [M]                      3.

SCREEN OPTIONS:
    1 -->  6 ALTER CORRESPONDING FIELD
    (D)ISPLAY SCREEN                 (H)ELP
    (O)K - EXIT WITH ENTERED DATA    (C)ANCEL - EXIT WITH ORIGINAL DATA
    (R)EVERT TO ORIGINAL DATA
SCREEN>  ok

VENT NUMBER= 2 IFROM= 1 ITO= 2
AREA=  .2000E+01 BOTTOM=  .0000E+00 TOP=  .2000E+01
```

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The data for a vent can be entered on one line by typing:

CCFM> vent 3 2 -1 1. 1. 2.

```
VENT NUMBER= 3 IFROM= 2 ITO=-1
AREA=  .1000E+01 BOTTOM=  .1000E+01 TOP=  .2000E+01
CCFM>
```

To see the data for all vents entered so far enter **VENT** *without any vent numbers. To see the contents of most CCFM.VENTS commands, type the command without any arguments.*

? vent

```
VENT NUMBER= 1 IFROM= 1 ITO=-1
AREA=  .2000E+01 BOTTOM=  .0000E+00 TOP=  .2000E+01
VENT NUMBER= 2 IFROM= 1 ITO= 2
AREA=  .2000E+01 BOTTOM=  .1000E+01 TOP=  .3000E+01
VENT NUMBER= 3 IFROM= 2 ITO=-1
AREA=  .1000E+01 BOTTOM=  .1000E+01 TOP=  .2000E+01
CCFM>
```

To specify a fire enter fire followed by the fire number. CCFM.VENTS allows up to 20 independent fires. Each fire can have its own time history , height above the floor and room of fire origin.

? fire 1

```
SCREEN INPUT MODE FOR COMM'ND:FIRE
FIELD                DESCRIPTION                         CONTENTS
  1    FIRE NUMBER                                  1
  2    ROOM NUMBER                                  1
  3    HEIGHT OF FIRE ABOVE FLOOR [M]               .000000000E+00
  4    FIRE SIZE [W] ENTER "V" TO SPECIFY MULTIPLE VALUES   .250000E+06

SCREEN OPTIONS:
  1 -->  4 ALTER CORRESPONDING FIELD
  (D)ISPLAY SCREEN               (H)ELP
  (O)K - EXIT WITH ENTERED DATA    (C)ANCEL - EXIT WITH ORIGINAL DATA
  (R)EVERT TO ORIGINAL DATA
SCREEN>
```

Change the fire size to 300000 [w] by typing 4 300000 ok .

? 4 300000. ok

```
FIRE NUM=  1 ROOM NUM=  1 FIRE HEIGHT=  .0000E+00FIRE SIZE=  .300000E+06
CCFM>
```

To enter parameters defining simulation start and finish times; print and dump intervals type:

? **time**

```
SCREEN INPUT MODE FOR COMMAND:TIME
FIELD                       DESCRIPTION                        CONTENTS
    1    START OF SIMULATION [S]                           .0000E+00
    2    END OF SIMULATION [S]                             .2000E+02
    3    PRINT TIME INTERVAL [S]                           .1000E+01
    4    DUMP TIME INTERVAL [S]                            .1000E+01
    5    PRINT AT ALL SOLVER STEPS (Y,N)                   N

SCREEN OPTIONS:
    1 --> 5 ALTER CORRESPONDING FIELD
    (D)ISPLAY SCREEN                (H)ELP
    (O)K - EXIT WITH ENTERED DATA   (C)ANCEL - EXIT WITH ORIGINAL DATA
    (R)EVERT TO ORIGINAL DATA
SCREEN>
```

Change the stopping time to 300 seconds, print and dump interval times to 10 seconds by typing:

? **2 300. 3 10. 4 10. ok**

```
   TSTART=   .0000E+00 TSTOP=   .3000E+03 DPRINT=   .1000E+02 DDUMP=   .1000E+02 PRI
NT ALL=N
CCFM>
```

The last data entry step should be to __automatically__ initialize pressures, layer heights and densities for each room. See the AUTO command entry in section 5 for a description of what is done by this command.

? **auto**

```
SCREEN INPUT MODE FOR COMMAND:AUTO
FIELD                       DESCRIPTION                        CONTENTS
    1    DENSITY [KG/M**3]                                 .1200E+01
    2    OXYGEN CONCENTRATION [(KG OXYGEN)/(KG LAYER)]
    3    PRODUCT 2 CONCENTRATION [(UNIT PROD 2)/(KG LAYER)]
    4    PRODUCT 3 CONCENTRATION [(UNIT PROD 3)/(KG LAYER)]
    5    PRODUCT 4 CONCENTRATION [(UNIT PROD 4)/(KG LAYER)]
    6    PRODUCT 5 CONCENTRATION [(UNIT PROD 5)/(KG LAYER)]

SCREEN OPTIONS:
    1 --> 6 ALTER CORRESPONDING FIELD
    (D)ISPLAY SCREEN                (H)ELP
    (O)K - EXIT WITH ENTERED DATA   (C)ANCEL - EXIT WITH ORIGINAL DATA
    (R)EVERT TO ORIGINAL DATA
SCREEN>
```
? **ok**

```
AUTO INITIALIZATION COMPLETE
CCFM>
```

Note: *Before you quit CCFM.VENTS or begin a model scenario you should record the scenario you entered with the dump command. The dump command creates a text file of CCFM.VENTS commands that can be used to re-create the case that you just entered. This file can be read with a text editor. This file may be loaded into CCFM.VENTS with the LOAD command.*

The dump command is used to create a text file of CCFM.VENTS that represents the given fire scenario. To create a file named dcase2 type:

? **dump dcase2**

```
THE FILE,DCASE2,HAS BEEN OPENED
DUMPING TO FILE:DCASE2
CCFM>
```

The file dcase2 can be examined with a text editor. The contents of this file are given in CCFM.VENTS Case 3.3.2 . To begin execution of a scenario just type:

? **begin**

The following text is what appears on your terminal screen when you run the two room tutorial.

```
THE FILE,OUTFULL,HAS BEEN OPENED
THE FILE,PLOTF,HAS BEEN OPENED
THE FILE,OUT1,HAS BEEN OPENED
*** GENERAL *** TIME=  .000000E+00
            PRESSURE      LAYER HEIGHT     L. TEMP          U. TEMP
   ROOM= 1  .000000000E+00   .300000000E+01   .295531250E+03   .295531250E+03
DERIVS=     .320000000E+03  -.986656137E-01   .275694420E+01  -.275694420E+01
   ROOM= 2 -.588000000E+01   .250000000E+01   .295514100E+03   .295514100E+03
DERIVS=    -.135763873E-07  -.762205266E-27   .000000000E+00  -.717840258E-11
*** GENERAL *** TIME=  .100000E+02
            PRESSURE      LAYER HEIGHT     L. TEMP          U. TEMP
   ROOM= 1  .493055580E-02   .221561685E+01   .295531284E+03   .323436504E+03
DERIVS=    -.950426968E-01  -.622215109E-01   .166360525E+01  -.186668974E+01
   ROOM= 2 -.587631557E+01   .250000000E+01   .295514158E+03   .295514158E+03
DERIVS=     .823545371E-01   .000000000E+00   .000000000E+00   .421434863E-04
*** GENERAL *** TIME=  .200000E+02
            PRESSURE      LAYER HEIGHT     L. TEMP          U. TEMP
   ROOM= 1  .286830139E-03   .172472573E+01   .295531344E+03   .329890834E+03
DERIVS=     .117776294E+00  -.341379961E-01   .849760720E+00  -.102410212E+01
   ROOM= 2 -.587661940E+01   .248667550E+01   .295514187E+03   .308770931E+03
DERIVS=    -.193700586E+00  -.487417899E-02   .139723280E+00  -.146327203E+00
```

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```
                              *
                              *
                              *

 *** GENERAL *** TIME=   .290000E+03
            PRESSURE        LAYER HEIGHT        L. TEMP         U. TEMP
   ROOM= 1  -.291567342E+00   .144213788E+01   .297818674E+03   .371812910E+03
DERIVS=      .426174738E-04   .847532039E-04  -.267329357E-02   .181805082E-02
   ROOM= 2  -.613091853E+01   .120412967E+01   .298335352E+03   .341233592E+03
DERIVS=     -.569357656E-04   .868143299E-03  -.272731515E-01   .246244329E-01
 *** GENERAL *** TIME=   .300000E+03
            PRESSURE        LAYER HEIGHT        L. TEMP         U. TEMP
   ROOM= 1  -.291847137E+00   .144294706E+01   .297864685E+03   .371869716E+03
DERIVS=      .780303515E-04   .770015714E-04  -.232412167E-02   .166867930E-02
   ROOM= 2  -.613076182E+01   .121244119E+01   .298427753E+03   .341671501E+03
DERIVS=      .198544733E-04   .793921806E-03  -.244998456E-01   .225329773E-01
```

CCFM Case 3.3.2   CCFM Commands for the Two Room Tutorial

```
; ----------------------------------------
; *** GENERIC CCFM INPUT ERROR CHECKS ***
; 0 GENERIC CCFM INPUT ERRORS FOUND
; ----------------------------------------
; ----------------------------------------
; PROPERTIES INDEPENDENT OF TIME
; ----------------------------------------

TIME , , ,    .1000E+02   .1000E+02 N
NUM    -1  -1  -1  -1  -1
CONS   .3500E+00    :8000E+00    .6000E+00    .10000E+04   .1013250E+06
CONV ABS    .1000E-05   .1000E-05   .1000E-05   .1000E-02   .1000E-02
CONV REL    .1000E-05   .1000E-05   .1000E-05   .1000E-02   .1000E-02
PARMS  2 N N
PATH
FILES,OUT1,OUTFULL,PLOTF
REPORT  Y N N Y Y N
OPTIONS N,,Y,, N
TITLE DUMP    DUMP TITLE
TITLE OUTPUT  OUTPUT TITLE
TITLE PLOT    PLOT TITLE

; FIRE PROPERTIES

FIRE   1   1    .000000E+00    .300000E+06

; ROOM DIMENSIONS

ROOM  1    .0000E+00    .3000E+01    .2500E+02
ROOM  2    .5000E+00    .2500E+01    .2500E+02


AMB  1    .0000E+00    .0000E+00    .1200E+01
AMB  1 ,,,,
```

```
; VENT DIMENSIONS

VENT  1  1 -1    .20000E+01    .00000E+00    .20000E+01
VENT  2  1  2    .20000E+01    .00000E+00    .20000E+01
VENT  3  2 -1    .10000E+01    .10000E+01    .20000E+01

; NO PRODUCTS DEFINED


;    -----------------------------------
;         PROPERTIES THAT DEPEND ON TIME
;    -----------------------------------

TIME 0. 300.
INIT  1    .00000000E+00    .30000000E+01    .12000000E+01    .12000000E+01
INIT  2  -.58800000E+01    .25000000E+01    .12000000E+01    .12000000E+01
```

4. Setting Up a Case

When CCFM.VENTS starts up, a menu of commands is displayed (see Figure 4.1). This menu consists of all of the possible commands or choices at the users disposal. There are four methods for entering data into CCFM.VENTS. These are **screen input mode, array input mode, command-line input mode** and a **text editor**. Screen Mode was used in the two room tutorial given in section 2. **Array input mode** is a variant of screen input mode used to input arrays of data. This mode of data input is used when entering a non-constant fire or entering a fan curve for modeling forced ventilation. Command line mode consists of using the CCFM.VENTS commands as defined in section 5. A text editor may be used to enter CCFM.VENTS' commands into a text file. This file would then be "loaded" into CCFM.VENTS with the LOAD command. This method would be used to make small changes in cases already set up.

Experienced users will probably find the Command Line mode more convenient, but it is recommended that beginners start out with the Screen Mode.

```
                       CCFM.VENT
CONSTANTS    MODEL      OUTPUT      MISC
------------------------------------------------

CONS         ROOM       PATH        OPTIONS
NUM          FIRE       FILES       BEGIN
CHECK        VENT       TIME        QUIT
CONV         FVENT      REPORT      LOAD
PARMS        INITP      TITLE       RERUN
FACTOR       INIT       VALUES      DUMP
AMB          AUTO                   HELP
```

Figure 4.1. CCFM.VENTS Command Menu

To ensure that the user knows the current input mode there is always a prompt for the type of input CCFM.VENTS is expecting. While in command line mode the string **CCFM>** appears against the left margin of the terminal screen. Similarly while in screen and array input mode the strings **SCREEN>** and **ARRAY>** appear at the left of the screen respectively.

4.1   Entering Data with Screen Input Mode

Screen input mode is used for commands with many arguments. This allows for more convenient data entry. To enter screen mode the user types a command followed by any indicator arguments that the command has. CCFM.VENT then displays a screen consisting of three columns of text followed by the various options. The first column indicates the field number. The second column contains a description of the field and the third column consists of the current value of the field. These descriptions are specified in the menu description file. Next, the available options are displayed. These options are listed in Table 4.1.1.

Table 4.1.1   Screen Input Options

Screen Option	Description
Change a field	**Type the field number** followed by its new value
Display	**Type a D** followed by a <return>. This option refreshes the screen with the latest values entered by the user.
Help	**Type an H** followed by a <return>. This option prints a short description of the command for which data is being entered.
OK	**Type an O** followed by a <return>. This option exits screen mode and saves all the data that the user entered.
Cancel	**Type a C** followed by a <return>. This option exits screen mode but does not save any of the data that the user entered.
Revert	**Type an R** followed by a <return>. This option re-loads the original data that was present when the user first entered screen mode

To enter screen input mode for the ROOM command type **ROOM** followed by a room number. For example, **ROOM 1**

```
SCREEN INPUT MODE FOR COMMAND:ROOM
FIELD                           DESCRIPTION                      CONTENTS
    1    INSIDE ROOM NUMBER                                  1
    2    FLOOR HEIGHT ABOVE DATUM ELEVATION [M]              .0000E+00
    3    CEILING HEIGHT ABOVE FLOOR [M]                      .3000E+01
    4    FLOOR AREA [M**2]                                   .2000E+02

SCREEN OPTIONS:
   1 -->  4 ALTER CORRESPONDING FIELD
  (D)ISPLAY SCREEN                  (H)ELP
  (O)K - EXIT WITH ENTERED DATA     (C)ANCEL - EXIT WITH ORIGINAL DATA
  (R)EVERT TO ORIGINAL DATA
SCREEN>
```

To obtain Help about a command while in screen mode type **Help** *to obtain:*

```
ROOM      IROOM, FHEIGHT, HCEIL, AROOM

          SET THE GEOMETRIC PROPERTIES OF THE ROOM SPECIFIED BY THE
          PARAMETER IROOM.

          IROOM    INSIDE ROOM NUMBER
          FHEIGHT  HEIGHT OF FLOOR ABOVE A REFERENCE HEIGHT
          HCEIL    HEIGHT OF CEILING ABOVE FLOOR
          AROOM    AREA OF FLOOR
```

This is the same information that is available in Section 5. of this report. There are two ways of exiting screen mode, typing OK or CANCEL. Typing OK causes the data that was entered to be processed by CCFM.VENTS. Typing cancel causes all data input to be discarded. To go back to the original data type REVERT. Again note that only the first character of the screen commands, DISPLAY, HELP, OK, CANCEL, REVERT are required.

4.2 Entering Data with Command-Line Input Mode

A command line is typed to enter data to CCFM.VENTS. It consists of one of the commands listed Table 5.1. followed by a list of arguments. A command may have none, one or several arguments. There are five types of arguments. These argument types are listed in Table 4.2.1. A command argument may be an integer, a floating point number, a boolean flag (e.g. yes/no) , a file

name or a general character string. Typically, integers are used as indexes, e.g. room numbers, vent numbers etc. Floating point arguments are used as model parameters. Boolean flags are used to set options on or off, file names are used to specify location of printed output and character string arguments are used for output titles, etc.

Table 4.2.1   CCFM Parameter Types

Parameter Type	Example of Usage
integer	Indexes: room or vent number
floating point	Model Parameters: room, vent area ; fire size
flag	An Option that is on or off: computing eigenvalues, running in batch
mode	
file name	Name of a file used for input, output, plotting
character string	Miscellaneous: used for titles, labels

Two arguments in a command line must be separated by either one or more spaces or comma. If two successive commas occur on a command line then the corresponding parameter is assumed to have been omitted. This is useful when a change in one parameter on a command line with many parameters is desired. Consider the following command line:

com1 , arg1 , , arg3, ,   arg5   arg6

The command is **com1**. This command has six arguments. The second and fourth arguments however are not specified as indicated by the successive commas. The command line:

room   2 .5   3.0   40.

initializes room 2 to have a floor height of .5 [m], a ceiling height of 3.0 [m] and a floor area of 40. [m²] .

4.3   Entering Data with Array Input Mode

A third type of input mode is used to enter array data.   Array input mode is similar to screen input

mode. Two commands, **FIRE** and **FVENT** use array input mode. These two commands are used to specify time dependent energy release rates for fires and pressure dependent volume flow rates for fans respectively. To enter fire size array data simply type a v for vector in the fire size field of the **FIRE** command. To enter a pressure dependent fan curve type a v in the fan curve field of the **FVENT** command. CCFM.VENT then displays a screen consisting of three columns of text followed by your options. For example, to enter a time dependent fire type **FIRE 1** to obtain:

```
   SCREEN INPUT MODE FOR COMMAND:FIRE
FIELD                    DESCRIPTION                            CONTENTS
    1   FIRE NUMBER                                      1
    2   ROOM NUMBER                                      1
    3   HEIGHT OF FIRE ABOVE FLOOR [M]                   .000000000E+00
    4   FIRE SIZE [W] ENTER "V" TO SPECIFY MULTIPLE VALUES   .250000E+06

SCREEN OPTIONS:
    1 -->  4 ALTER CORRESPONDING FIELD
    (D)ISPLAY SCREEN                (H)ELP
    (O)K - EXIT WITH ENTERED DATA   (C)ANCEL - EXIT WITH ORIGINAL DATA
    (R)EVERT TO ORIGINAL DATA
SCREEN>
```

To enter array input mode type:

4 vector ok

The following screen then appears.

```
   ARRAY INPUT MODE FOR COMMAND:FIRE
       FIELD                          TIME              FIRE SIZE
         1                     .000000000E+00      .250000000E+06
         2

VECTOR OPTIONS:
    1 -->  2 ALTER CORRESPONDING FIELD
    (D)ISPLAY SCREEN                 (H)ELP
    (O)K - EXIT WITH ENTERED DATA    (C)ANCEL - EXIT WITH ORIGINAL DATA
    (R)EVERT TO ORIGINAL DATA        (S)ORT DATA
    (E)LIMINATE DATA BETWEEN BOUNDS
VECTOR>
```

The options D, H, O, C, R are identical to the options used in screen input mode. Array input mode has two new options: E and S. These two options eliminate data points and sort data pairs by the first coordinate. To add additional points type a field number followed by a time and fire size. For example to specify a fire of 1000000 [w] at 100 seconds enter:

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2 100 1000000 display

This will cause the screen to display:

```
ARRAY INPUT MODE FOR COMMAND:FIRE
     FIELD                        TIME              FIRE SIZE
       1              .000000000E+00        .250000000E+06
       2              .100000000E+03        .100000000E+07
       3

VECTOR OPTIONS:
    1 -->  3 ALTER CORRESPONDING FIELD
   (D)ISPLAY SCREEN            (H)ELP
   (O)K - EXIT WITH ENTERED DATA   (C)ANCEL - EXIT WITH ORIGINAL DATA
   (R)EVERT TO ORIGINAL DATA      (S)ORT DATA
   (E)LIMINATE DATA BETWEEN BOUNDS
VECTOR>
```

Several data pairs can be entered at a time as in:

3 50. 500000. 4 75. 750000. display

```
ARRAY INPUT MODE FOR COMMAND:FIRE
     FIELD                        TIME              FIRE SIZE
       1              .000000000E+00        .250000000E+06
       2              .100000000E+03        .100000000E+07
       3              .500000000E+02        .500000000E+06
       4              .750000000E+02        .750000000E+06
       5

VECTOR OPTIONS:
    1 -->  5 ALTER CORRESPONDING FIELD
   (D)ISPLAY SCREEN            (H)ELP
   (O)K - EXIT WITH ENTERED DATA   (C)ANCEL - EXIT WITH ORIGINAL DATA
   (R)EVERT TO ORIGINAL DATA      (S)ORT DATA
   (E)LIMINATE DATA BETWEEN BOUNDS
VECTOR>
```

Notice that the times listed in the first column are not in order. To sort and re-display the screen type: **Sort Display** to obtain:

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```
ARRAY INPUT MODE FOR COMMAND:FIRE
     FIELD                              TIME              FIRE SIZE
       1                          .000000000E+00      .250000000E+06
       2                          .500000000E+02      .500000000E+06
       3                          .750000000E+02      .750000000E+06
       4                          .100000000E+03      .100000000E+07
       5

VECTOR OPTIONS:
   1 -->  5 ALTER CORRESPONDING FIELD
  (D)ISPLAY SCREEN                    (H)ELP
  (O)K - EXIT WITH ENTERED DATA     (C)ANCEL - EXIT WITH ORIGINAL DATA
  (R)EVERT TO ORIGINAL DATA          (S)ORT DATA
  (E)LIMINATE DATA BETWEEN BOUNDS
VECTOR>
```

Finally to eliminate data type E followed by a lower and upper bound. To eliminate all values between 40 and 80 seconds type: **E 40. 80. D** to obtain:

```
SCREEN INPUT MODE FOR COMMAND:FIRE
     FIELD                              TIME              FIRE SIZE
       1                          .000000000E+00      .250000000E+06
       4                          .100000000E+03      .100000000E+07
       5

VECTOR OPTIONS:
   1 -->  5 ALTER CORRESPONDING FIELD
  (D)ISPLAY SCREEN                    (H)ELP
  (O)K - EXIT WITH ENTERED DATA     (C)ANCEL - EXIT WITH ORIGINAL DATA
  (R)EVERT TO ORIGINAL DATA          (S)ORT DATA
  (E)LIMINATE DATA BETWEEN BOUNDS
VECTOR>
```

Array input mode options are listed and defined in Table 3.2.1.

Table 4.3.1   Array Input Options

Array Option	Description
Change a field	**Type the field number** followed by its new value
Display	**Type a D** followed by a <return>. This option refreshes the screen with the latest values the user entered.
Help	**Type an H** followed by a <return>. This option prints a short description of the command the user is entering data for.
OK	**Type an O** followed by a <return>. This option exits screen mode and saves all the data that the user entered.
Cancel	**Type a C** followed by a <return>. This option exits screen mode but does not save any of the data that the user entered.
Revert	**Type an R** followed by a <return>. This option re-loads the original data that was present when the user first entered screen mode
Sort Data	**Type an S** followed by a <return>. This sorts the data in column 1 (time in the following example) in increasing order and makes the corresponding changes in column 2 (fire size)
Eliminate Data	**Type a E** followed by a **lower bound, upper bound** and a <return>. This option allows the user to delete data by specifying a range of values.

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5. Descriptions of CCFM.VENT Commands

The following is a listing of descriptions of all CCFM.VENTS commands. Each entry includes a summary of the command's purpose and a description of the number and type of arguments required. Table 5.1 gives a list of all the CCFM.VENTS commands with abbreviations for their input arguments.

Table 5.1	List of CCFM.VENT Commands
AMB	oroom , fheight, poffset, dens, ocon, pcon1, ..., pconNPROD-1
AUTO	dens, ocon, pcon1, ..., pconNPROD-1
BEGIN	
CONS	lamr, lamt, lamw, cp, pdatm, ddatm
CONV	absrel, tol1, tol2, tol3, tol4, tol5
DUMP	dfile, dmptim
FACTOR	fnum, factor1, factor2, ... , factorNPROD
FILES	scrfil, outfil, pltfil, dmpfil
FIRE	fnum, fheight, fsize
FVENT	vnum, frmrm, frmhght, torm, tohght, resis, fcrv, frmwdth, towdth
HELP	command
INIT	iroom, poffset, hlay, denl, denu
INITP	iroom, prdnum, pconl, pconu
LOAD	lfil, ltime
NUM	nirm, norm, nvnts, nprod, nfire
NUMINF	. .
OPTIONS	traceflg, menuflg, ttyflg, iolevl, batchflg
PARMS	iflogo, discflg, eigflg
PATH	path
REPORT	genflg, prdflg, flwflg, numflg, debflg, pltflg
ROOM	iroom, fheight, hceil, aroom
STOP	
TIME	tstart, tstop, dprint, ddump, prntflg
TITLE	ttype, title
VALUES	
VENT	vnum, frmrm, torm, varea, vbot, vtop

The commands listed in Table 5.1 are defined in the following pages.

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AMB   **oroom, fheight, poffset, dens, ocon=pcon$_1$, pcon$_2$, ..., pcon$_{NPROD}$**

This command specifies the ambient conditions for an "outside" room. (Up to 4 outside rooms are allowed in this version of CCFM.VENTS. The concentrations of up to 3 products of combustion, can be simulated in the inside rooms of a modeled facility in this version of CCFM.VENTS. This includes oxygen, which is taken to be product 1. The concentrations of each of these products must be specified in each outside room.

oroom	Outside room number; 1 to 4.
fheight	Reference elevation relative to the datum elevation. [m]
poffset	Reference pressure relative to the datum pressure at the reference elevation. [p] = [N/m^2] = [kg/(m•s)^2]
dens	Density of the environment in the outside room. [kg/m^3]
ocon=prod$_1$	(Required if the number of products simulated, NPROD, satisfies: 1 ≤ NPROD ≤ 4.) Concentration of oxygen of the environment in the outside room. [(kg of O$_2$)/(kg of environment)]
pcon$_k$	(Required if the number of products simulated, NPROD, satisfies: 2 ≤ NPROD ≤ 3.) Concentration of all products-of-combustion k > 1 in the outside room. [(unit of product k)/(kg of environment)]

AUTO   **dens, ocon=pcon$_1$, pcon$_2$, ..., pcon$_{NPROD}$**

Assume an initial condition of zero upper-layer thickness in all inside rooms of a modeled facility. Assume further uniform initial density and uniform concentrations of all simulated products of combustion inside and outside the facility. Then, satisfying a criterion of zero flow through all natural vents in the absence of a fire or in the absence of any operating forced ventilation systems, this command initializes automatically the CCFM.VENTS inside-room solution variables: pressure at the floor above a datum pressure; elevation of the interface which separates the layers; mass in the lower layers; and the amount in the lower layers of each simulated product k. Prior to using **AUTO**, the user must first define the geometry of the facility by specifying for each inside room (using **ROOM**): the elevation of the floor relative to a datum elevation, the elevation of the ceiling above the floor, and floor area; and for each outside room a(n identical) reference elevation above the datum elevation and the pressure there relative to the datum pressure.

dens	Initial density in all inside-room lower layers and throughout the outside environment. [kg/m^3]
ocon=pcon$_1$	(Rec red if the number of products simulated, NPROD, satisfies: 1 ≤ NPF D ≤ 3.) Concentration of oxygen in all inside-room lower layers and throughout the outside environment. [(kg of O$_2$)/(kg of layer)] or [(kg of O$_2$)/(kg of environment)]
pcon$_k$	(Required if the number of products simulated, NPROD, satisfies: 2 ≤ NPROD ≤ 3.) Con entration of all products-of-combustion k > 1 in the inside-room lower ayers and throughout the outside environment. [(unit of product k)/(kg of layer)] or [(unit of product k)/(kg of environment)]

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BEGIN

Begin simulating the specified fire scenario.

CONS   **lamr, lamt, lamw, cp, pdatm, ddatm**

This command is used to specify various constants used by CCFM.VENTS.

lamr	Fraction of the total energy release rate of the fire radiated by the combustion zone and plume (default 0.35).
lamt	Fraction of the total energy release rate of the fire lost to the bounding surfaces of the room of fire origin by all modes of heat transfer (default 0.8).
lamw	Define the "enthalpy of buoyancy" of a uniform temperature vent flow as the enthalpy of the flow computed relative to the temperature in the receiving room local to flow penetration. Then lamw is the fraction of the enthalpy of buoyancy lost to the bounding surfaces of the receiving room (default 0.6).
cp	Specific heat of air at constant pressure (default 1000.). [W•s/(kg•K)]
pdatm	datum pressure, the absolute hydrostatic pressure at the datum elevation (default 101325.). [p] = [N/m^2] = [kg/(m•s)^2]
ddatm	datum density (default 1.2). [kg/m^3]

CONV   **absrel, tol1, tol2, tol3, tol4, tol5**

The command **CONV** sets the error criteria that the solvers will use to generate solutions. In general the smaller the tolerances the more accurate the solutions but at a cost of longer execution time (usually). Actually the relationship between tolerance size and computational effort is not simple. It is possible to tighten the tolerance for pressure and reduce cpu time required to solve a problem! Oxygen and product of combustion error tolerances are only required if these quantities are being solved for.

absrel	The parameter absrel may be either the string **'ABS'** or **'REL'** which stands for absolute and relative error respectively.
tol1	error criteria pressure equation
tol2	error criteria for layer height equation
tol3	error criteria for mass equations (both layers)
tol4	error criteria for oxygen equation (both layers)
tol5	error criteria for all other products (both layers

DUMP   **dfile, dmptim**

This command creates a file of CCFM.VENT commands. The parameter **dfile** represents the name of the file where CCFM.VENT commands are to be stored. While the model is running, results will be dumped to the file DFile every **dmptim** seconds. The DUMP command can be used to save simulation results for later use. The dump file may then be read in with the **LOAD** command. The simulation will then proceed using the conditions stored in the dump file. For example, if a dump file contains a calculation to 300 seconds with a dump time interval of 10 seconds then the calculation could be restarted at 300 seconds (or any of 10, 20, ... 290 seconds) and continued to 500 seconds with a dump interval of 5 seconds. CCFM.VENT

commands may also be created using a text editor or word processor. Any CCFM.VENT command may occur in a dump file except for a **LOAD** command.

dfile   Name of file where CCFM.VENT commands are to be stored.
dmptim   Time interval in seconds between successive dumps.

FACTOR   fnum, factor$_1$, factor$_2$, ..., factor$_{NPROD}$

This command specifies the proportionality constants used to determine the rate at which the fire releases the NPROD ≤ 5 products of combustion whose concentrations are being simulated. It is assumed that the rate of release of arbitrary product k, $\dot{P}_{k,SOURCE}$, can be estimated according to

$$\dot{P}_{k,SOURCE} = factor_k \cdot \dot{Q}_{fnum}$$

where $\dot{Q}_{fnum}$ is the energy release rate of the fnum'th fire. Here, product of combustion 1 always refers to oxygen.

fnum   The fire number; from 1 to 20.
factor$_1$ (Required if NPROD ≥ 1.) Proportionality constant for oxygen (default -7.6E-8). [(kg of O_2)/(W•s)]
factor$_k$ (Required if NPROD ≥ 2.) Proportionality constants for all products k > 1. [(unit of product k)/(W•s)]

FILES   scrfil, outfil, pltfil, dmpfil

scrfil   Scratch output file. This file need only be examined if the simulation run ended abnormally. Since the normal output file, **scrfil**, would not be built. The output in this file is scrambled because in general many types of reports (specified by the **REPORT** command) are generated. This file is unscrambled and copied to the file specified by the parameter **outfil**.
outfil   Output file containing results of the simulation..
pltfil   File containing the simulation results. This file is used by other programs to produce graphs of simulation results.
dmpfil   File containing dump of simulation results. Note: this file name can also be specified with the **DUMP** command.

FIRE   fnum, froom, fheight, fsize

This command specifies the characteristics of a prescribed fire.

fnum   The fire number; from 1 to 20.
froom   The room containing the fire; from 1 to 9
fheight   Height of the fire above the floor. [m]
fsize   Data defining the fire's energy release rate. If the string 'vector' is specified, then the user will be asked to enter pairs of values (fire energy release rate, time) [W, s]

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which lie on the specified fire growth curve. (In a simulation, the fire growth is approximated by linear interpolation between these points, and by extension in time beyond the points at the "last" specified energy release rate. Otherwise, this field is used to specify the energy release rate of an assumed constant strength fire.

FVENT   **vnum, frmrm, frmbot, frmtop, frmresis, torm, tobot, totop, toresis, fcrve**

This command specifies the characteristics of a fan/duct forced ventilation system between two rooms. The forward flow direction is defined as the direction of the flow under normal fan operating conditions, from the "from" room to the "to" room. Reverse flow is flow in the opposite direction.

vnum	Number designation of the vent from 1 to 20.
frmrm	Room "from" which the vent flow is extracted under normal fan operating conditions.
frmbot	Height above the floor of the bottom of the fan/duct endpoint in the "from" room. [m]
frmtop	Height above the floor of the top of the fan/duct endpoint in the "from" room. [m]
frmresis	Flow resistances, R_1, of the fan system for forward flow as defined in Eq. (3.4.2) of Part I and in algorithms VENTF and FANRES of Part III. $[p^{1/2}kg^{-1}s] = [\{kg/(m \cdot s^2)\}^{1/2}kg^{-1}s]$
torm	Room "to" which the vent flow is deposited under normal fan operating conditions.
tobot	Height above the floor of the bottom of the fan/duct endpoint in the "to" room. [m]
totop	Height above the floor of the top of the fan/duct endpoint in the "to" room. [m]
toresis	Flow resistances, R_2, of the fan system for reverse flow as defined in Eq. (3.4.2) of Part I and in algorithms VENTF and FANRES of Part III. $[p^{1/2}kg^{-1}s] = [\{kg/(m \cdot s^2)\}^{1/2}kg^{-1}s]$
fcrve	Data defining the fan curve. If the string 'v' for vector is specified, then the user will be asked to enter pairs of values (fan volume flow rate, cross-fan pressure) $[m^3/s, p]$ which lie on the fan curve. (In a simulation, the fan curve is approximated by linear interpolation between, and linear extrapolation beyond these points. The fan curve must satisfy the characteristic that cross-fan pressure is always monotonically decreasing with increasing fan volume flow rate.) Otherwise, this field is used to specify an assumed-constant fan/duct volume flow rate $[m^3/s]$ (in which case, an entry in the resis field is not required or used).

HELP   *command*

This command enables the user to obtain more information about a command while using CCFM.VENT. By typing HELP followed by a CCFM.VENT command, a short explanation of how to use the command and its purpose will be given.

INIT   **iroom, poffset, hlay, denl, denu**

This command initializes values of CCFM.VENTS solution variables in inside room identified by the number **iroom**. Note: to initialize these variables for all rooms see AUTO command.

iroom	Number designation of the inside room from 1 to 9.
poffset	Pressure at the floor above the datum pressure. $[p] = [N/m^2] = [kg/(m \cdot s)^2]$

hlay	Elevation above the floor of the interface which separates the layers. [m]
denl	Density of the lower layer. [kg/m^3]
denu	Density of the upper layer. [kg/m^3]

INITP   **iroom, prdnum, pconl, pconu**

This command initializes the amount of a product of combustion, identified by the number **prdnum**, in the layers of the inside room identified by the number **iroom**. Note: to initialize the amount of product for all rooms see **AUTO** command.

iroom	Number designation of the inside room from 1 to 9.
prdnum	Number designation of the combustion product from 1 to 3 of the product being initialized.
pconl	Amount of product in the lower layer. [unit appropriate to the product, e.g., kg of O_2 for oxygen] Note: the concentration of the product in the lower layer will be units of [(unit of product)/(kg of lower layer)].
pconu	Amount of product in the upper layer. [unit appropriate to the product]

LOAD   **lfil, ltime**

This command executes CCFM.VENT commands found in the file specified by lfil. The parameter, ltime, is used to restart a simulation run from a given point in time. So that one does not have to re-run simulations when investigating behavior near the end of the simulation.

lfil	Name of file containing CCFM.VENT commands.
ltime	Load CCFM.VENT commands from the file LoadFil at or just before the time specified by time.

NUM   **nirm, norm, nvnts, nprod, nfire**

CCFM.VENT's automatically determines the number of inside/outside rooms, vents, fires and products that were defined in the input data. The command, NUM, then allows the user to over-ride what CCFM.VENT determined for these values. To find out what these values are use the NUMINF command. So one could **LOAD** a data file that had two products defined and then run a scenario and turn off products by setting the number of products to zero with NUM. Important note: a value of -1 (any negative number in fact) causes CCFM.VENT to use its default value for the corresponding quantity.

nirm	Number of inside rooms, may range from 1 to 9
norm	Number of outside rooms, may range from 0 to 4.
nvnts	Number of vents, may range from 0 to 20. The program will identify rooms that are isolated, i.e. rooms that do not communicate with any other rooms as a possible error. This will occur if the number of vents is set to zero.
nprod	Number of products, may range from 0 to 3.
nfire	Number of fires, may range from ' '0.

NUMINF

Display the number of inside/outside rooms, vents, products and fires that have been entered so far.

OPTIONS traceflg, prntflg, ttyflg, iolevl, batchflg

The command OPTIONS is to set options/flags available to CCFM.VENT.

traceflg	TRACE is an internal debug option used to determine the execution flow path by printing a message upon entering and leaving routines in CCFM.VENT. Note: the trace option is no longer implemented.
menuflg	Set whether the CCFM.VENT menu is to be printed out after each command line is entered.
ttyflg	Set whether information should be displayed to the terminal screen.
iolevl	Determines what level of message will be printed out. (default 0) There are four levels or types of messages that are printed out by CCFM.VENT. These levels are:

informative	A level 0 message, just communicates information to the user by displaying model results, for example. There is no connotation of an error or problem with this type of message.
warning	A level 1 message, indicates a possible problem that may or may not require corrective action. Example -
error	A level 2 message, indicates a situation requiring some action to remedy. Further results are suspect unless the problem is corrected. Example - an input command is entered incorrectly,
fatal error	A level 3 message indicates a problem has been encountered where no conceivable action can be taken to remedy the situation. Example - division by 0.

With the LEVEL command, one can set the minimum level of a message that is printed. So for example, the command, LEVEL 2, will cause only error and fatal error messages to be printed.

batchflg The batch option signals CCFM whether it is running interactively (at a terminal) or in batch mode. The only difference in the program is how CCFM treats an end of file.

PARMS iflogo, discflg, eigflg

The command PARMS sets options/flags available to CCFM.VENT.

iflogo	Set which flow deposition algorithm should be used. The only valid entry for this parameter is 2.
discflg	Specify whether a heuristic is to be used to handle non-analytic (discontinuity type) behavior that may be present in the physical equations. If the heuristic is not used then the solver will have to proceed through the discontinuity on its own. Yes will turn on the heuristic, no will turn it off (default no)

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eigflg   Calculate the eigenvalues of the Jacobean of the right hand side of the ODE being solved. This command is used solely to investigate the numerical properties of a fire scenario being modeled. **Yes** will turn the option on, **no** will turn it off. (default no)

PATH   **path**

The command **PATH** is useful on any computer that has some type of hierarchial file system, i.e. a file system that supports directories (MS-DOS compatible PC's) or folders (the Macintosh). The string **path** is used to prefix the files: **scrfil, outfil, pltfil** and **dmpfil** which are specified with the **FILES** command. So the user can keep the program, CCFM, in one folder or directory and keep data files in another without specifying long file names.

REPORT   **genflg, prdflg, flwflg, numflg, debflg, pltflg**

The **REPORT** command determines which reports are to be produced by CCFM.VENT.

genflg   **General report**; prints out layer height, upper/lower layer density, and upper/lower layer oxygen concentration if calculated for each room.

prdflg   **Product report**; prints out product concentration for each product for each room. This report is necessary when one models more than one product since there is only room for Oxygen concentrations on the general report.

flwflg   **Flow report**; prints out various types of flow due to various types of phenomena for each room. Flow types consist of mass, enthalpy, and combustion products such as oxygen. Phenomena types presently consist of plumes, forced and un- forced vents. In addition flow totals for each room are printed.

numflg   **Numerics report**; Prints out information describing the work required to solve the scenario. Some examples of the types of information printed are, time in seconds from last step to generate results, number of iterations required, solution variable that caused the solver the most work.

usrflg   **User report**; Prints out information generated by the subroutine OUTUSR.

pltflg   **Plot report**; Prints out information that will be read in by the plotting program CFMPLOT.

RERUN   **dfile, ovrflg**

This command reads in the dump file, **dfile**, created in a previous run of CCFM. It then generates the same simulation results as the command, **BEGIN**. That is, both commands store printed results in the files: **outfil** and **pltfil** which are defined by the **FILES** command. With the **BEGIN** command the solution vector of pressures, layer heights, etc. are generated by solving a set of ordinary differential equation. This is computationaly expensive. However, with the **RERUN** command each solution vector is simply read in from the dump file, **dfile**. The size of a dump file in lines can be estimated from the following formula.

```
lsize = 100 +ndes*numstps
ndes = nirm*(4+2*nprod)
```

lsize   estimated number of lines of text in the dump file
100   approximate number lines of time independent data in the dump file
ndes   number of ode's being solved
nirm   number of inside rooms
nprod   number of products of combustion being modeled
numstp   number of time steps that appear in dump file

dfile   dump file from which simulation results are to be re-generated
ovrflg   if ovrflg is set to yes then any files command in the dump file, dfile will be ignored.

ROOM   iroom, fheight, hceil, aroom

This command sets the geometric properties of the room identified by the number **iroom**.

iroom   Number designation from 1 to 9 of the inside room being initialized.
fheight Height of the floor above the reference elevation. [m]
hceil   Height of the ceiling above the floor. [m]
aroom   Floor area. [m^2]

STOP

Exit the program CCFM.VENT without running a simulation.

TIME   tstart, tstop, dprint, ddump, prntflg

tstart   beginning of the simulation (default 0 seconds)
tstop   end of the simulation (default 20 seconds)
dprint   time in seconds between printed output
ddump   time in seconds between dumped output
prntflg Yes will produce simulation output at all internal time steps calculated by numerical
         solver. This option is useful when debugging. 'No' will only produce output at the
         printing interval specified by the parameter dprint. 'No' is the default.

TITLE   ttype, title

Set titles for dump, output and plot files. This command would be used to annotate various
output files produced by CCFM.VENT

ttype   Type of title, presently the choices are **DMP, OUT** or **PLT**
title   The title, may be as long as will fit on one line up to 80 characters

VALUES

Display values entered by user defining the fire scenario being modeled.

VENT   vnum, frmrm, torm, varea, vbot, vtop

This command specifies the characteristics of a rectangular vertical vent in a wall segment common to two adjacent rooms. At least one of the rooms should be an inside room, while the second can be an inside or outside room. One of the inside rooms is designated arbitrarily as the "from" room. The other room is designated as the "to" room.

vnum	Number designation from 1 to 20 of the vent being initialized.
frmrm	Number designation from 1 to 9 of the "from" room. This must be an inside room.
torm	Number designation of the "to" room. If this is an inside room, then this number must be from 1 to 9. If this is an outside room, then this number must be from -1 to -4.
varea	Area of the vent. [m^2]
vbot	Elevation of the bottom of the vent above the floor of the "from" room. [m]
vtop	Elevation of the top of the vent above the floor of the "from" room. [m]

6. CCFMPLT - A Program to Plot CCFM.VENTS Output Data

At each time-step CCFM.VENTS outputs simulation results to a plot data file. This file contains 8 columns of data and NIRM rows for each time step where NIRM is number of inside rooms. The first column of data is relative pressures, the second is layer heights, the third and fourth are lower/upper layer temperatures respectively. If oxygen concentrations were computed then the 5'th and 6'th columns contain lower/upper layer oxygen concentrations. If they were not computed then the 5'th and 6'th columns contain mass flow rates into the lower and upper layers. SImilarly if a second product of combustion is computed then the 7'th and 8'th columns contain the lower/upper layer product concentrations other wise these columns contain enthalpy flow rates in to the lower/upper layers.

A FORTRAN program, named CCFMPLT, was written to graph the data contained in this file. It uses a FORTRAN callable graphics package called Volksgrapher [1]. The program runs on an IBM-PC or compatible that has a VGA monitor and a numerical co-processor.

The program asks for the name of a CCFM.VENTS plot file, titles of plots, type of output format and a file name prefix where output graphics will be stored

To generate plots for the two room tutorial entered in section 3.2 the following. Note that **text typed by the user appears like this** while text displayed by the computer looks like this.

CCFMPLT

Enter name of file containing plot data: **PLOTF**

Enter title of plots: **Two-Room Tutorial Plots**

Preview plots on screen ? Y=YES: **Y**

Enter Output device format:

1 - Tektronix

2 - HPGL-Plotter

3 - PostScript

4 - QMS-Lasergrafix

: **3**

```
Enter the file name where Plots will be stored
It can be up to 6 characters: **TUTOR**
```

The program now prints a message stating that it is reading the data file. It then plots the first plot of relative pressures for each room vs. time. A legend appears in the middle of the plot showing which curve corresponds to which rooms. To move this legend type: **L** . This places the program in to legend mode. To move the legend around the plot use the cursor keys (keys with arrow on them). When the legend placement is satisfactory type: **D** followed by **X**. The D causes the legend to be re-drawn while the X causes the screen to be refreshed. To create a high-quality graphics file type **P**. The program asks for the name of the file where the graphics output is to be stored. To continue to next graph type: **C**. A plot of relative pressure vs. time is given in Figure 6.1 and a plot of layer height vs. time is given in Figure 6.2. Both plots are taken from data generated from the two-room tutorial case presented in section 2.
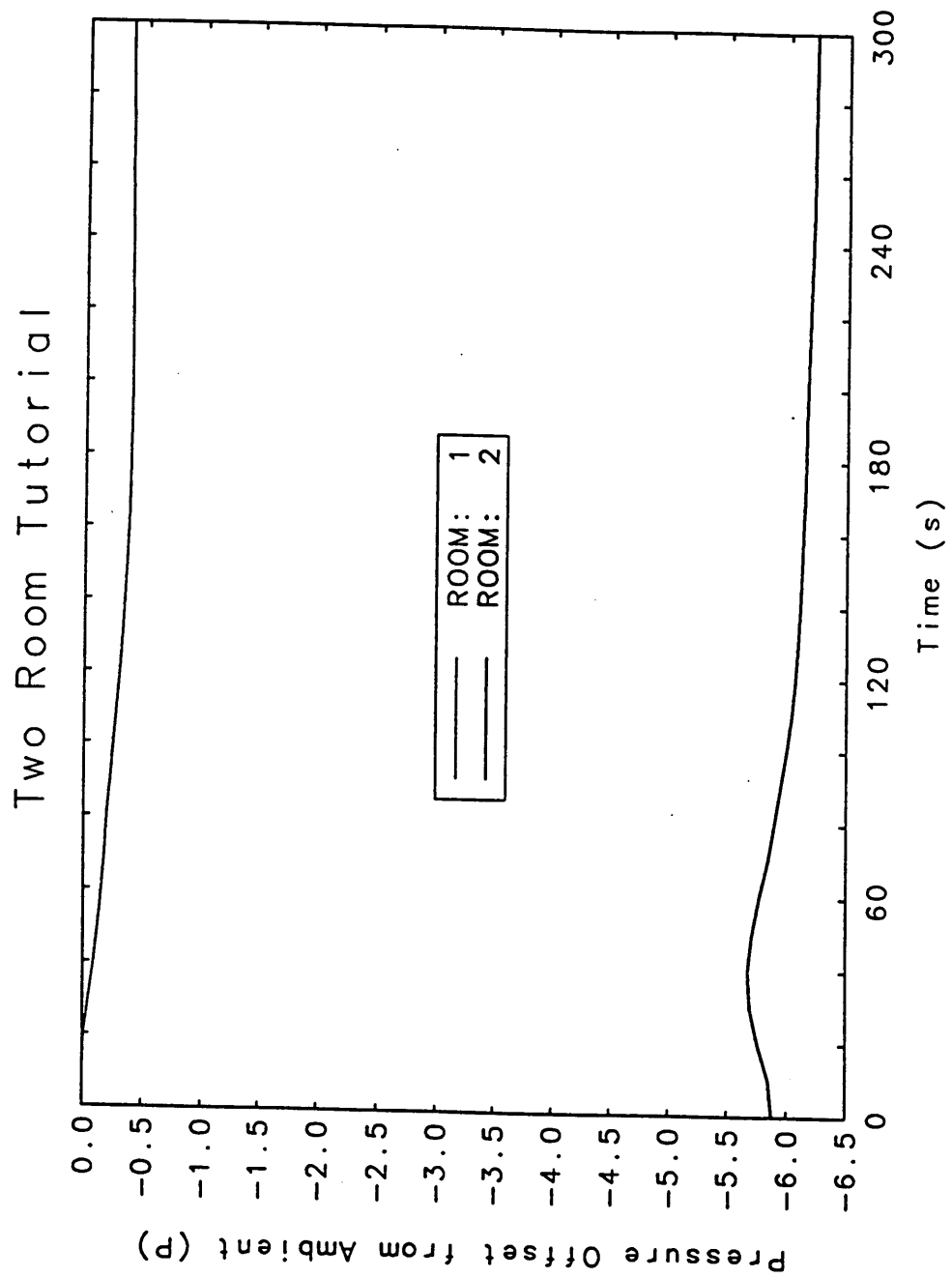
Figure 6.1 Plot of Relative Pressure vs. Time for the Two-Room Tutorial
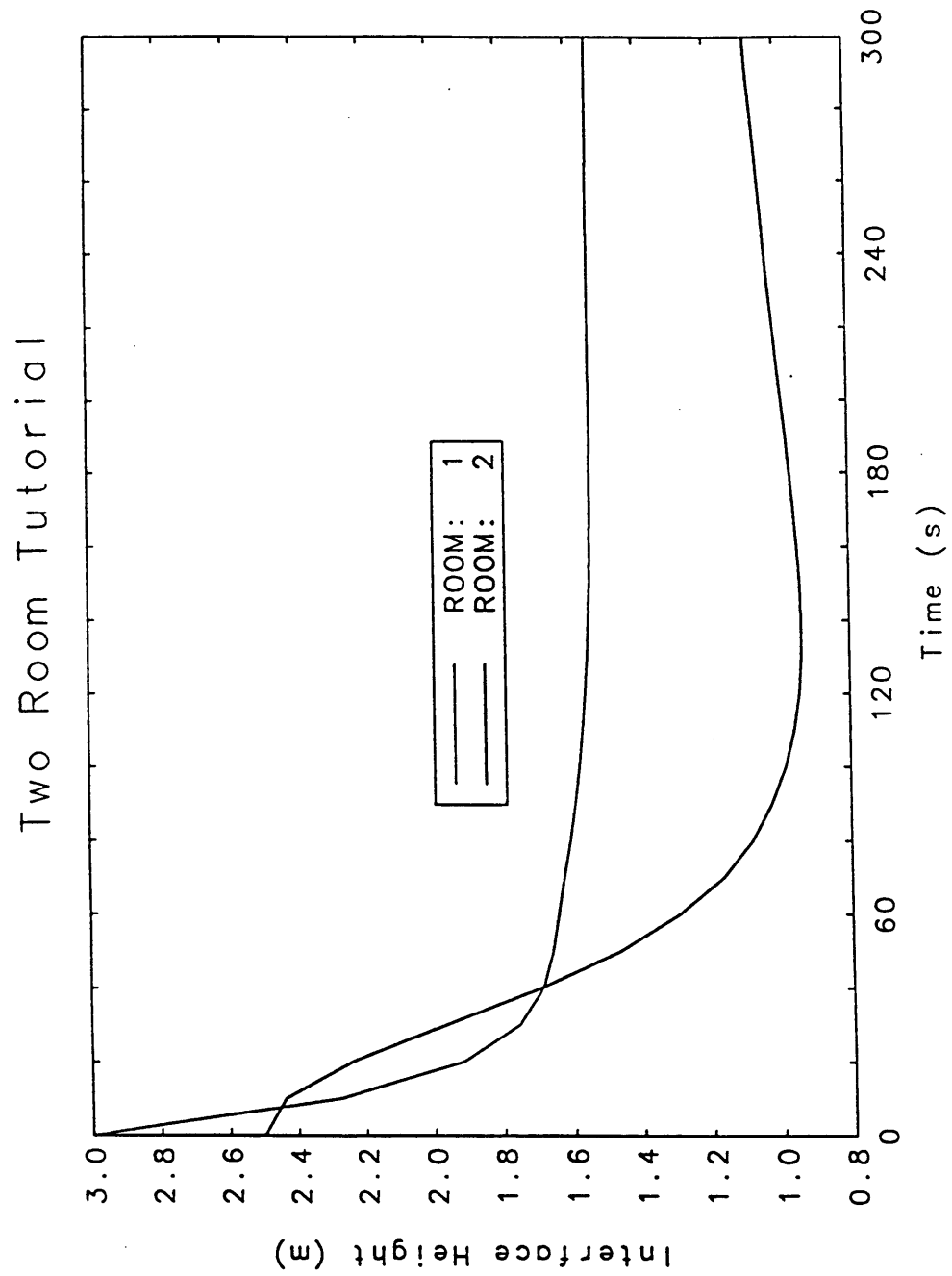
Figure 6.2 Plot of Layer Height vs. Time for the Two-Room Tutorial

REFERENCES

[1]   Kahaner, D.K. and Anderson, W.E., Volksgrapher: A FORTRAN Plotting Package User Guide, Version 3.0, NISTIR 90-4238, National Institute of Standards and Technology, Gaithersburg MD, 1990.

[2]   Cooper, L.Y. and Forney, G.P., The Consolidated Compartment Fire Model (CCFM) Computer Code Application CCFM.VENTS - Part I: Physical Basis, NISTIR 90-4342, National Institute of Standards and Technology, Gaithersburg MD, 1990.

[3].   Forney, G.P. and Cooper, L.Y., The Consolidated Compartment Fire Model (CCFM) Computer Code Application CCFM.VENTS - Part II: Software Reference Guide, NISTIR 90-4343, National Institute of Standards and Technology, Gaithersburg MD, 1990.

[4]   Forney, G.P. and Cooper, L.Y., Eds., The Consolidated Compartment Fire Model (CCFM) Computer Code Application CCFM.VENTS - Part III: Catalog of Algorithms and Subroutines, NISTIR 90-4344, National Institute of Standards and Technology, Gaithersburg MD, 1990.

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11. ABSTRACT (A 200-WORD OR LESS FACTUAL SUMMARY OF MOST SIGNIFICANT INFORMATION. IF DOCUMENT INCLUDES A SIGNIFICANT BIBLIOGRAPHY OR LITERATURE SURVEY, MENTION IT HERE.)

A project was carried out at The National Institute of Standards and Technology (NIST) to study the feasibility of developing a new-generation, multi-room, compartment fire model computer code, called the Consolidated Compartment Fire Model (CCFM) computer code. The idea was that such a code would consolidate past progress in zone-type compartment fire modeling, and allow readily for integration of future advances with the greatest possible flexibility. The project lead to the development of a prototype multi-room CCFM product called CCFM.VENTS.

This is Part IV of a four-part report which documents the above effort. The main objective of this Part IV document is to document the use of CCFM.VENTS. Its capabilities and limitations are described. A simple two room tutorial is presented to get the user quickly acquainted with the input requirements of CCFM.VENTS. Each CCFM.VENTS command is described. Finally, a program for -plotting CCFM.VENTS data is presented. This program runs on an IBM-PC or compatibles with a VGA graphics monitor.

The other three parts of this report are: Part I: Technical Basis; Part II: Programmers Reference Guide; and Part III: Catalog of Algorithms and Subroutines.

12. KEY WORDS (6 TO 12 ENTRIES; ALPHABETICAL ORDER; CAPITALIZE ONLY PROPER NAMES; AND SEPARATE KEY WORDS BY SEMICOLONS)

building fires; compartment fires; computer models; fire models; mathematical models; vents; zone models

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